

Laminate Suspension System

Field of the Invention

The present invention relates to a glazing unit and particularly a novel glazing unit having unique means for mechanically fastening such glazing units to be fixed to a supporting structural glazing assembly for forming a continuous façade having an extensively smooth outer surface from such glazing units.

Description of the Prior Art

Various technological arrangements are known for mounting glazing units to provide the aesthetical and architectural benefits of continuous glazed facades which are typically fixed on high rise buildings. Generally the glazed façade assembly in the form of glass panels or units is mechanically secured to a substructure of the façade. The substructure is mounted on the outside of a load bearing building skeleton of metal or reinforced concrete. However, the means for mechanical fastening for this purpose involves some projecting parts and/or providing fastening holes through the layers of glass which distort the outer surface of the panels.

In an attempt to obtain the desired smooth outer surface of the façade form which no parts are projecting and the individual glass units remain integral, the glass panes were mounted exclusively by means of adhesive bonding. For safety reasons, building authorities have not generally permitted such glass facades without positive locking. Moreover, the prior art methods are limited to certain thickness of glass.

The current practice in façade construction is described in U.S. Patent No.

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4,381,868 to McCann, which is incorporated herein by reference, discloses mechanically fastening sections of glass panels to the supports of a building. That patented glass assembly comprises a planar array of sealed multiple glazing units each comprising two opposed spaced sheets with a seal between the sheets defining a sealed gas space, which units are secured to supporting members with the outer surface of the units sealed edge-to-edge, at least some of the units being secured to the supporting members by a mechanical fixing passing through the outer sheets of the units outside the seals of the units. In a preferred embodiment each unit is a multiple glazing unit which is secured to the supporting member by bolts whose heads are countersunk into holes countersunk in the outer face of the unit outside of the seal of the unit. The outer surface of the outside sheet of the glazing unit is protected against destructive stress cracks by cushioning and bushings and washers placed between the bolt and the glazing surfaces. The bushings and washers prevent glass-to-metal contact and prevent damage to the glazing sheets.) 3

There are several disadvantages in the patented glass assembly directed to aesthetics and the manner of assembly. The holes required to accommodate the attaching bolts weaken the entire unit, destroy the integrity and smooth surface of the outer panel. The flat headed bolts even if countersunk into the glass detract from the uninterrupted planar appearance of the outside of the assembly. The necessity to carefully drill through multiple layers of glass and align these pieces constitutes a difficult and costly manufacturing problem. The drilling of glass to produce a countersunk hole usually requires two steps and may entail considerable glass breakage. Likewise, if the holes are

Fig. 3 shows a sectional view of a plurality of the laminated glass glazing units 20 as illustrated in **Fig. 2** forming a glazing assembly of planar rectangular panels.

Fig. 4 is a cross-sectional view of a double glazing unit having a female securing element in the form of a flange and stud.

Fig. 4A is a cross sectional view along line **y-y** of **Fig. 4**.

Detailed Description of the Preferred Embodiments

Referring to drawings Figs. 1 to 4 there are illustrated a novel single glazing unit, a laminated glazing unit and a glazing assembly according to his invention. A plurality of these glazing units when arranged in a planar array and mechanically secured to a concealed structural support member of a building form a glazing assembly having a monolithic façade with aesthetical and practical architectural benefits.

The simplest application of this invention as shown in **Fig. 1** involves a single monolithic glazing unit 10 which comprises a monolithic external glazing element 11 such as a glass glazing having a smooth outer surface 11a and an inner surface 11b bonded to an internal polymer layer 12 which is preferably an ionomer having surfaces 12a and 12b and embedded therein at least one male mechanical securing element 7 such as bolt 17. The bolt 17 comprises a flat head 18 and a threaded stem 16. As shown in the figure, the flat head 18 is totally embedded within the polymer layer 12 in a fixed position with the threaded stem 16 projecting from the glazing unit 10. A female mechanical fixing element nut 19 is connected to the threaded stem 16 to form a mechanical securing assembly and enables the monolithic glazing unit to be secured to a

structural support 14 (partially shown) by tightening the nut 19. The inherent properties of adhesive strength and high tensile strength of the polymer locks the flat head 18, increases the load bearing capacity of the mechanical securing assembly and accepts increased load bearing pressure.

In practice the installation of the monolithic glazing unit 10 to a support structure 14 involves passing the threaded end 16 of the bolt 17 through a bushing 13 and circular hole 15 of support structure 14. The hole 15 has a diameter slightly larger than the threaded stem 16 to provide adequate clearance to compensate for the monolithic glazing unit 10 which is secured to the support structure 14 by tightening nut 19 on the threaded stem 16 at face 12b of the ionomer layer 12. The tightening action causes pressure to be distributed through the bushing 13. The bushing 13 is of sufficient size and elasticity to accommodate relative movements between the ionomer layer 12 and the structural support 14.

A plurality of the monolithic glazing units 10 may be employed in a planar array as a building façade or an interior ceiling and wall assembly in which each of the laminated glazing units are secured to a support structure by mechanical securing assembly wherein at least one element of the assembly is embedded in the polymer layer of the laminate.

The term "monolithic" as used herein relates to a glazing element to be integral, i.e., without holes or fragmentations.

In Fig. 2 there is shown a laminated multiple glazing unit, specifically a glass double glazing unit 20 comprising an external glass element 21 having an outer surface

21a and an inner surface 21b and an internal glass element 23 also having outer and inner surfaces 23a and 23b which are bonded together with polymer interlayer 22. The interlayer 22 has embedded therein a female securing element such as a capped nut 27. A circular fixing hole 24 is formed through the internal glass element 23 and has a diameter slightly larger than that of the mechanical fixing element 26. In this case the male fixing element is a bolt 26 comprising a head 25 and a threaded end which is sized to engage the embedded capped nut 27. As seen in Fig. 3, the laminated glazing assembly 30 (Fig. 2) is constructed from a plurality of laminate multiple glazing units. Each glazing unit has an uninterrupted outer surface which can be secured to a concealed supporting framework to provide an uninterrupted planar appearance of the outside of the assembly. Preferably, the multiple glazing unit is a laminated glass double glazing unit 20 as described in Fig. 2. This glazing unit 20 is integrated with the mechanical connection with bolt 26. The facade assembly procedure for attachment of each glazing unit 20 typically involves units having rectangular or square shapes with the mechanical securing element embedded in each corner. In this case the threaded end of bolt 26 is passed through hold 15 in support structure 14 through bushing 28 and through fixing hold 24 to connect with embedded capped nut 27.

After engaging the capped nut 27 the bolt head 25 is torqued to exert force on bushing 28 which distributes the pressure to the inner surface 28 which distributes the pressure to the inner surface 23b thus securing the glazing unit 20 to the support structure 14. Various arrangements of compressible elastomeric gaskets, washers, and seals in addition or in place of the bushing shown may be used to avoid glass-to-metal contact

and prevent damage to the glazing sheets. Such arrangement and choice of compressible and/or flexible material is clearly known in the glazing art.

The critical feature of the invention resides in that at least one of the mechanical securing elements is embedded in an ionomer or polymer layer or interlayer. The mechanical securing assembly useful in this invention results from the interaction of male-female components either of which may be embedded in the ionomer layer without any consequence.

The terms "external" and "internal" as used herein refer to the position of these elements relative to the façade.

Fig. 3 illustrates a laminated glass double glazing assembly 30 comprising a planar array of laminated glass double glazing units 20 as shown in **Fig. 2** each of which are mechanically secured at their respective corners to conceal support members 14 behind the array which are part of a structural framework to which the glazing assembly 30 is secured. The outer glass glazing surface 21a of the double glazing units 20 are positioned edge-to-edge so as to appear to be continuous. However, a small gap between adjacent edgers can remain and this can be sealed with a silicone sealant as indicated at 31 if required.

Fig. 4 shows another embodiment of this invention in which a female mechanical securing element ~~50~~⁵¹ as shown in **Fig. 4A** is embedded in the polymer layer 42. The construction of the securing element ~~50~~⁵¹ involves a metal flange 49 attached to an internally threaded stud 48. Additionally the flange has a plurality of spaced apart circular holes 51. These holes provide additional surface areas for adhesion to the

ionomer polymer layer 42. The laminated double glazing unit 40 comprises external glass glazing element 41 ^{with outer surface 4a} and internal glass glazing element 43 ^{with outer surface 43a} bonded together with the polymer interlayer 42 having embedded therein the female securing element 50. A bolt 45 having a threaded end provides the necessary male securing element. The bolt head 44 is torqued to tighten the glazing unit for attachment to a support structure 14. In this construction the weight of the glazing unit is borne by the polymer layer 42. Preferably, the flange and stud are welded together and employ stainless steel as the material of construction.

The glazing material preferred for either external or internal elements may be any with known commercial plate float or sheet glass compositions. The glass may be tempered or non-tempered or chemically strengthened. Synthetic polymers to which the ionomer polymer resin provides good adhesion which includes polycarbonate resins, fused acrylic/polycarbonate resins, polyurethane, etc. The invention contemplates the use of one or more inner or outer layer of various polymer combinations preferably the inner layer is an ionomer layer and has embedded therein the mechanical securing element. The glazing material may range from transparent to opaque, may be tinted or deeply colored. The glazing material may include coatings which provide specific properties or special effects such as reflecting and non-reflecting properties, ultraviolet radiation absorbing, etc.

The thickness of the glazing may vary from about 8 mm to 19 mm for the external unit and between about 5 to 15 mm for the internal unit. The thickness of the ionomer polymer layer or interlayer will range from 3 to 60 mm. The good adhesion and the high